Insight into Regional Atmospheric Variability from Five Decades of High- Resolution Model Downscaling over California

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Objective

- **Reconstruction** of the **high-resolution/high-temporal scale analysis** of **atmosphere** and **land** covering the **state of California**, neighboring states and ocean **for global change study.**
  - **Longest possible analysis**
  - **Highest possible resolution**

Methodology

- **Dynamical downscaling**
  - **Using complex atmospheric model to interpolate large scale analysis to regional space and time scale.**
  - **Advantage**
    - **The fields obtained are dynamically, thermodynamically and hydrologically consistent (difficult for statistical technique).**
      - **Can be used to "understand" the dynamics and physics.**
  - **Disadvantage**
    - **Model dependent. Accuracy uncertain. ➔Importance of validation.**

Model and data

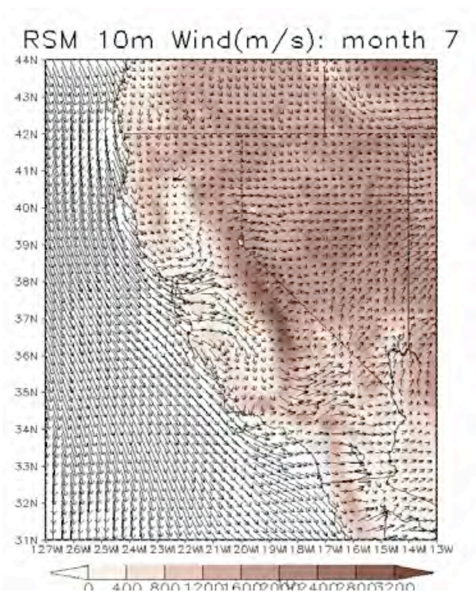
- Scripps Experimental Climate Prediction Center Hydrostatic Global to Regional Spectral Model (G-RSM).
  - ➔ **Max possible resolution of ~10km.**
- NCEP/NCAR Global Reanalysis as a large-scale forcing.
  - ➔ **Only analysis that goes back to 1948.**
- Apply **Scale Selective Bias Correction** technique to preserve the large-scale forcing field within the domain.
- **No other observations**, except SST, are used.
  - Does not incorporate change in land use.
  - Response due to change in large scale atmospheric circulation and SST.
- Hourly output.

Two experimental phases

1. Extended California region

Jan. 1948-Aug. 2005
Completed!

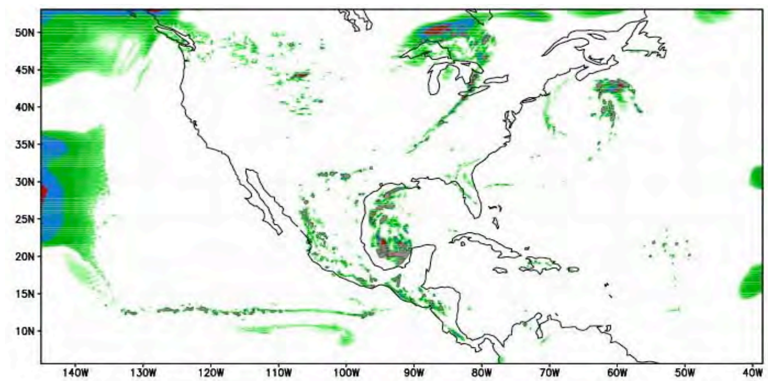
Ran on NCAR and multiple National Super Computing center machines.



2. Extended North American region.

In progress

Running on Earth Simulator machine in Yokohama, Japan. To be completed by 2006.

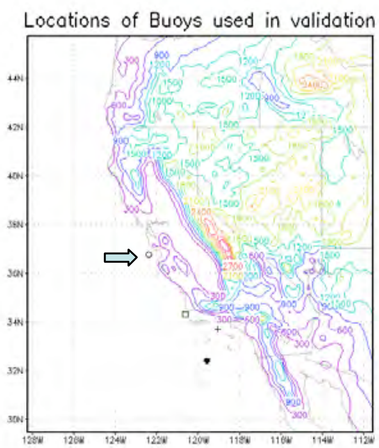


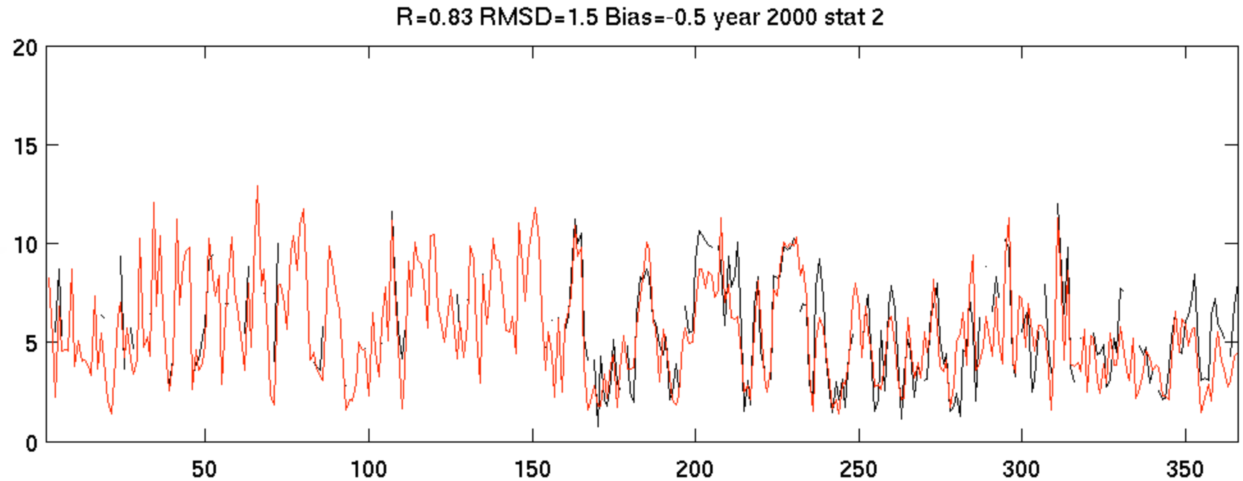
Challenges

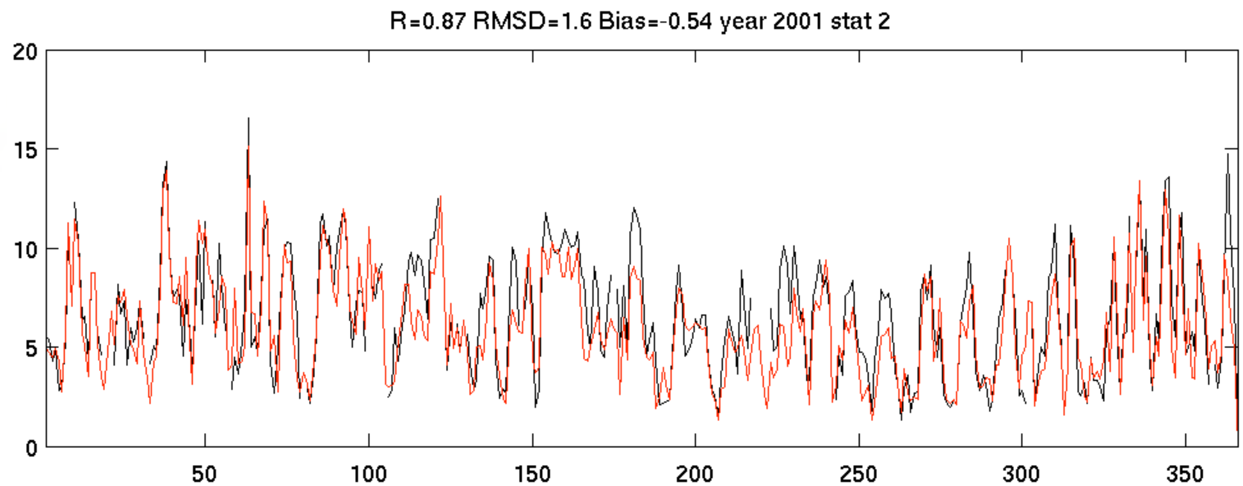
- Computational – *solved*
- Validation – *this presentation*
- Fact finding and diagnostics – *this presentation*
- Sensitivity tests – *in progress*
- Improvement – *future work*

Validation examples

Validation of daily mean buoy wind speed

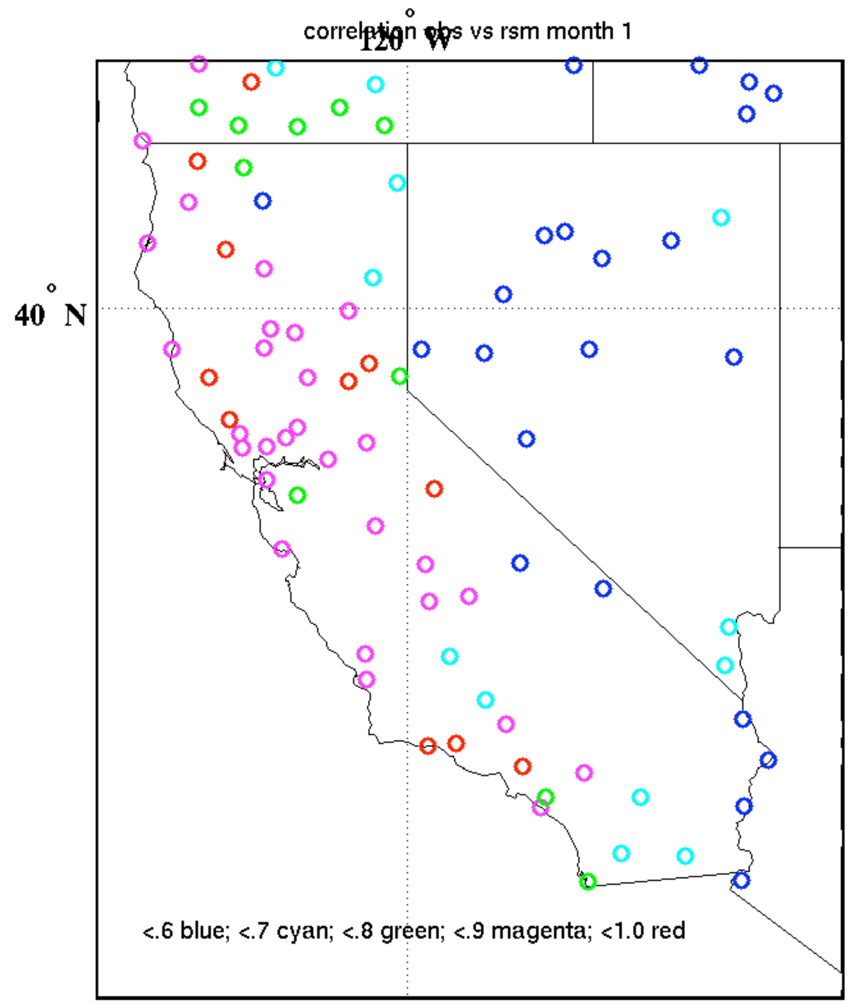




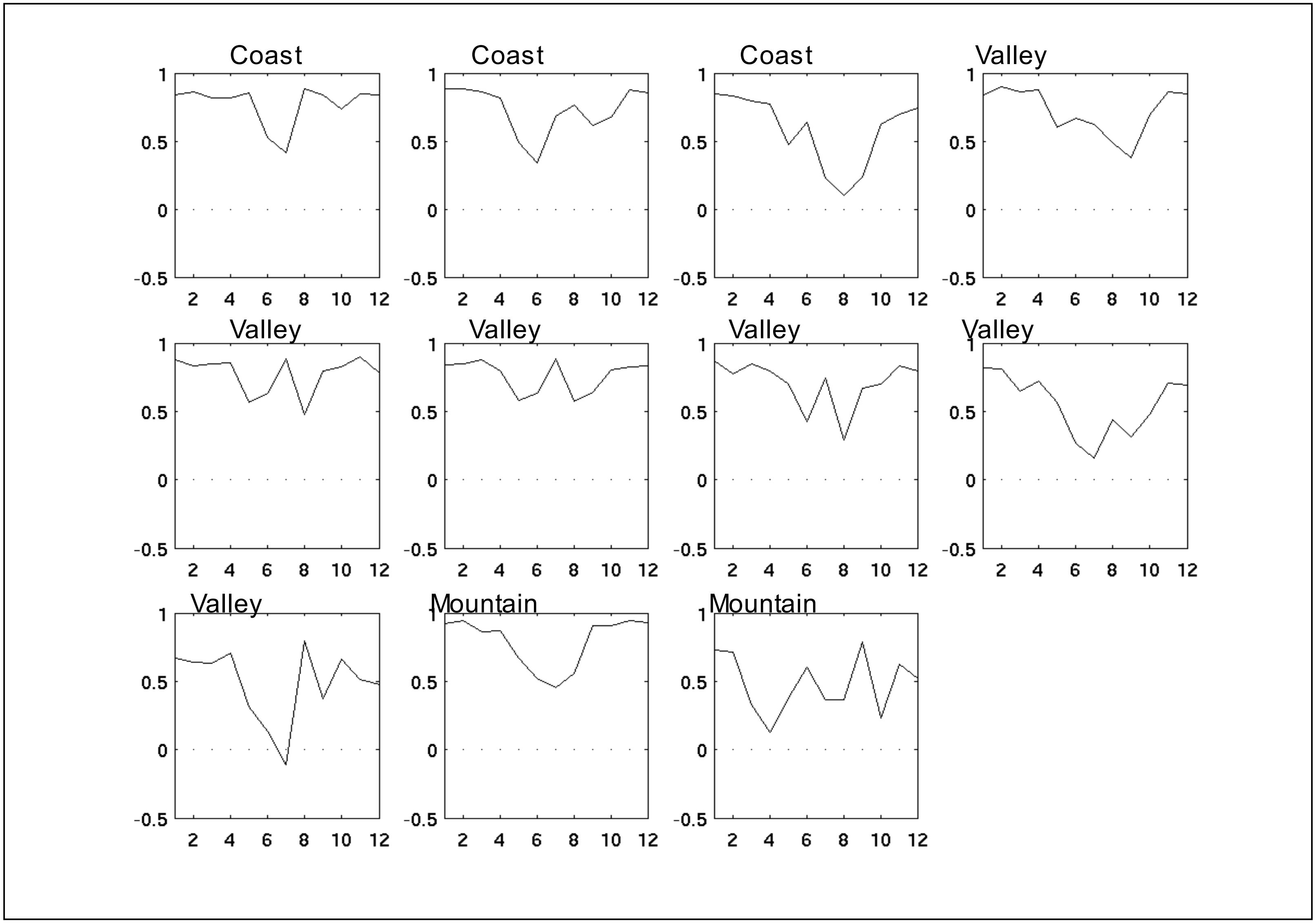


Buoy 2-b42

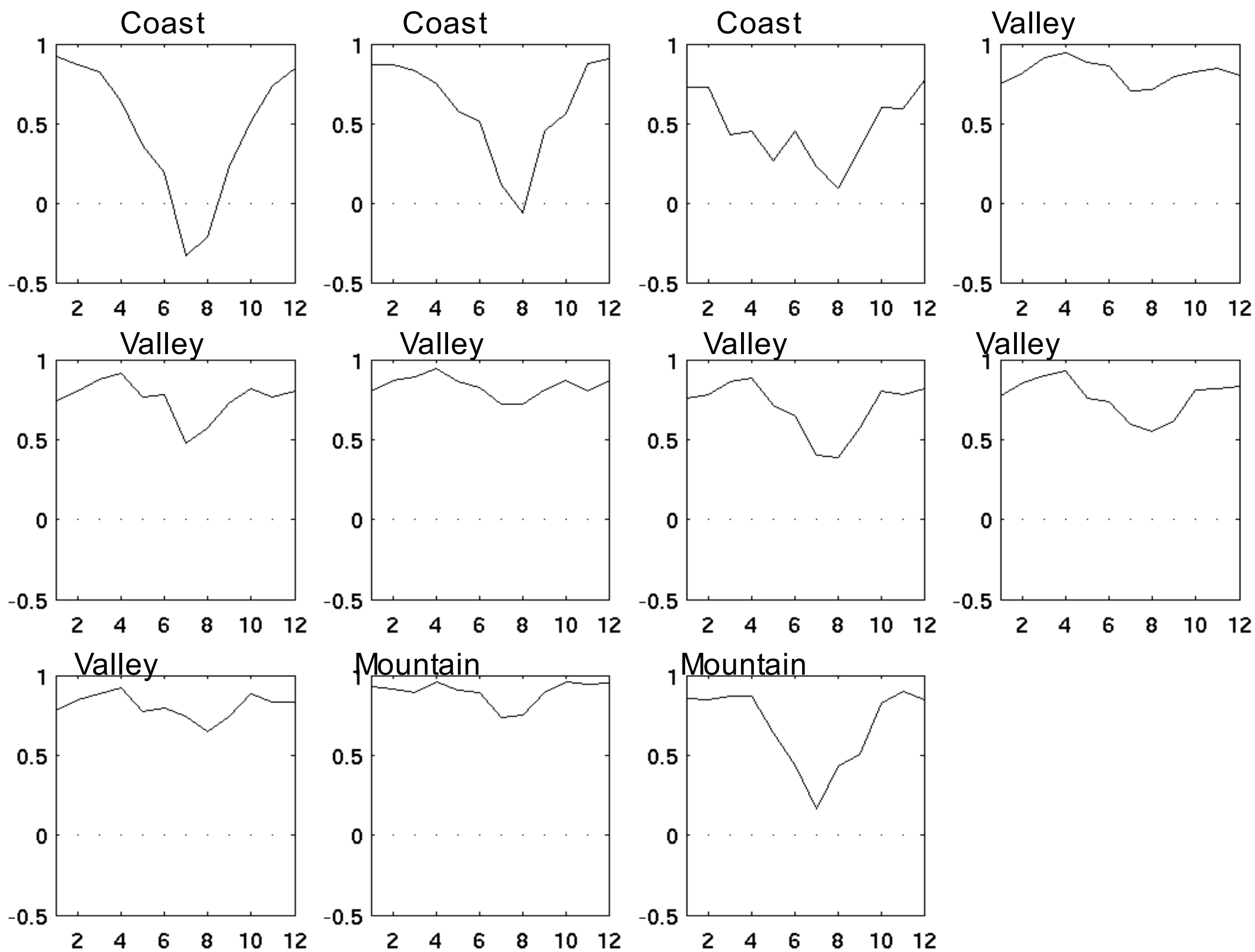
Validation over land
January Average Precipitation



Seasonal change of correlation of monthly mean Precipitation



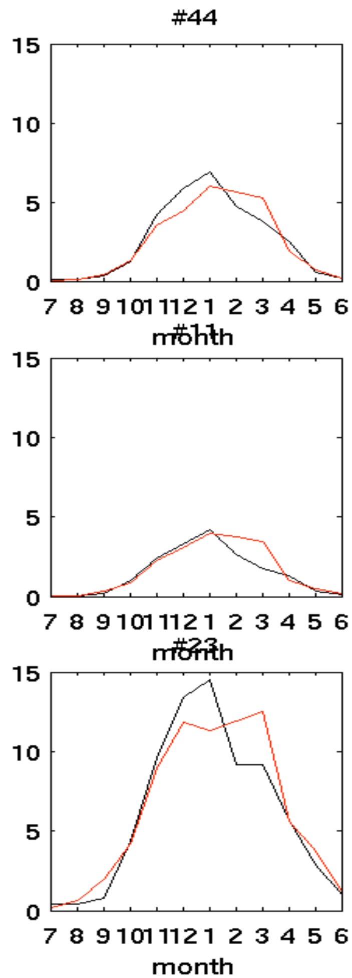
Seasonal change of correlation of monthly mean 2m T



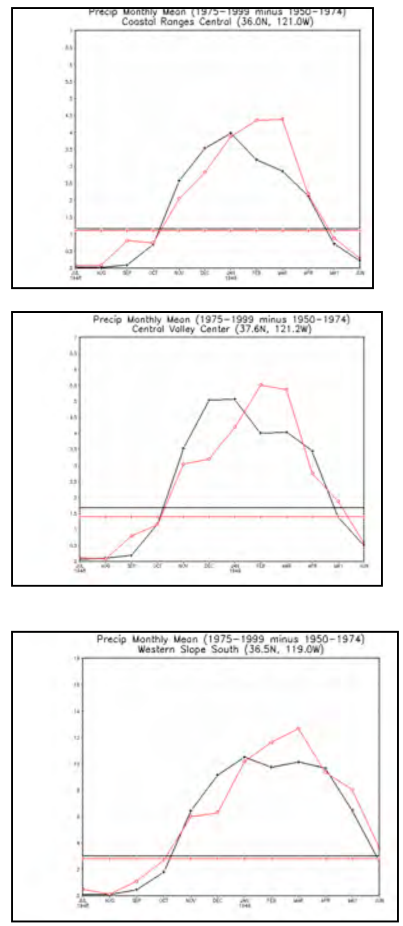
Validation - Decadal Variation

Seasonal change of precipitation

Obs.



Model



Red: 1975-96

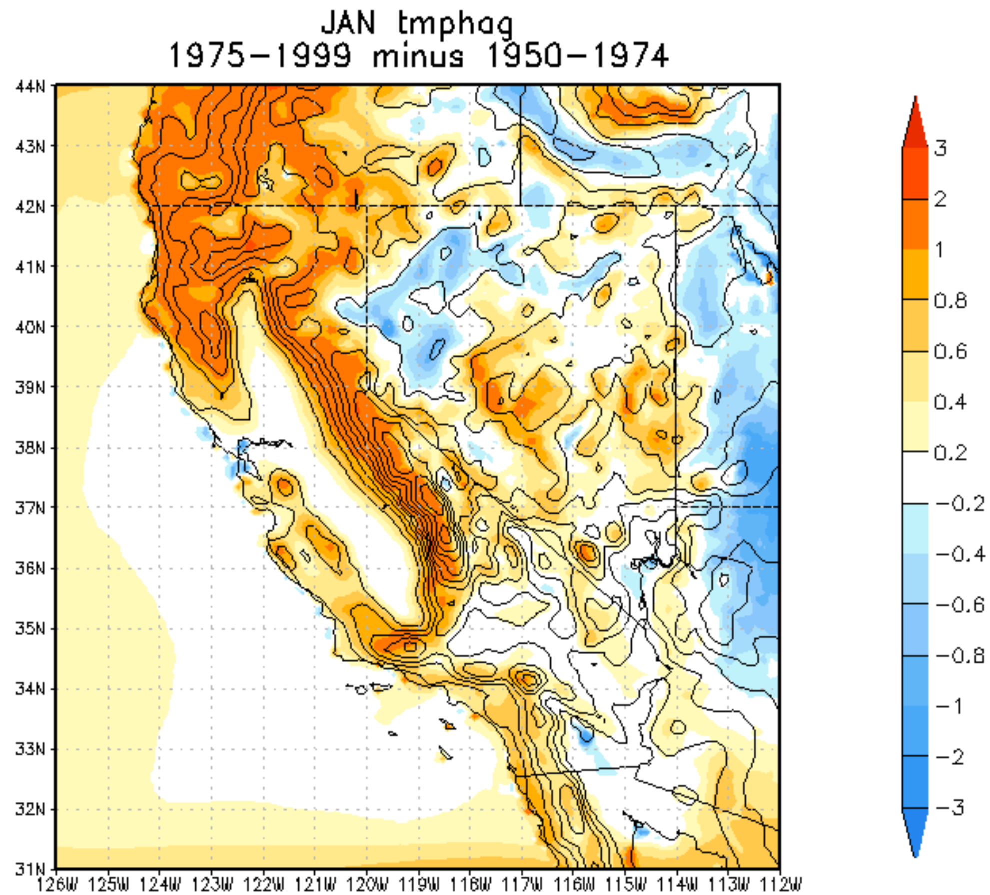
Black: 1950-74

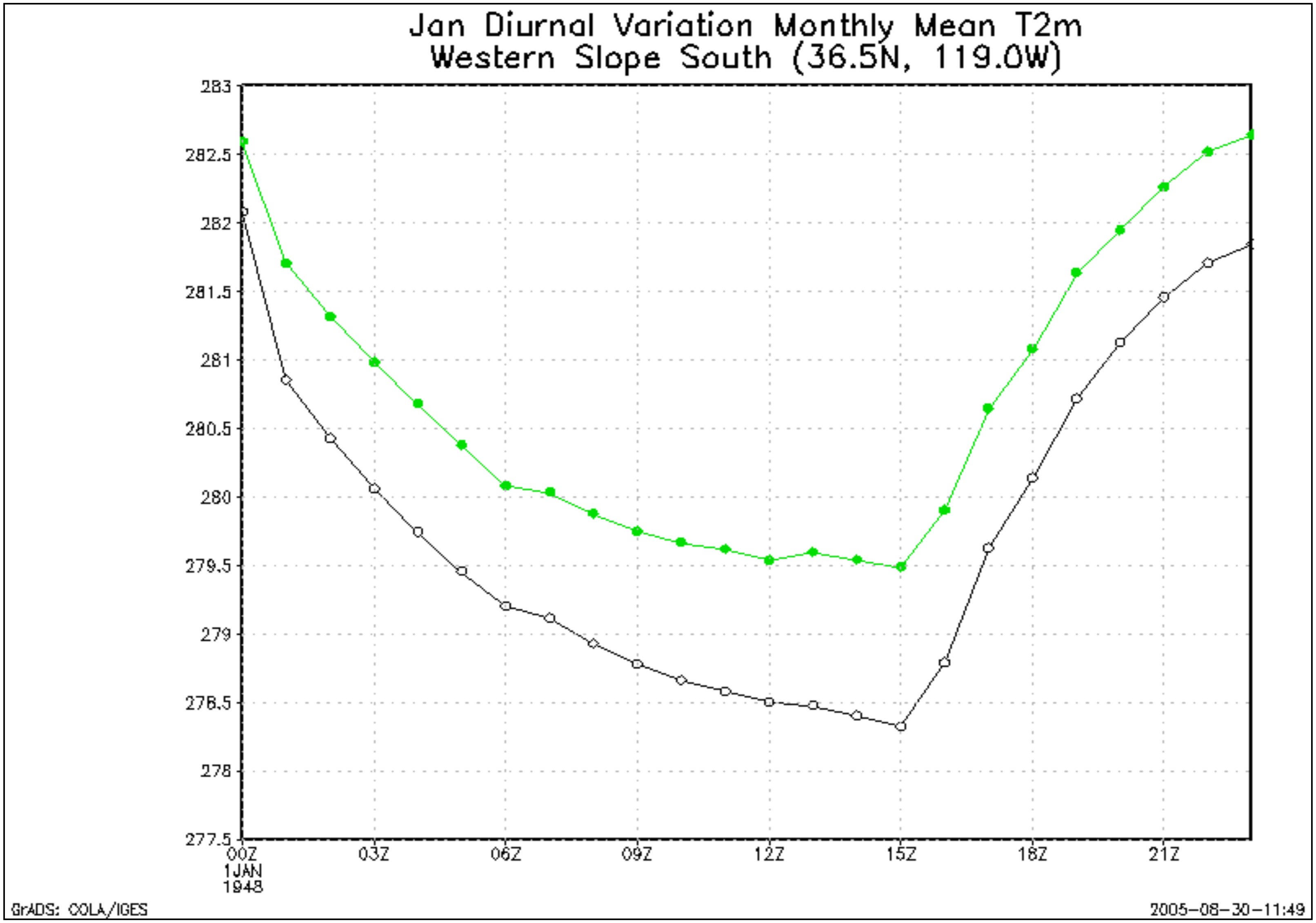
January 2mT trend comparison (°K/Year)

(Obs. 1950-1996 ,Model 1950-1999)

	Station ID	January	
		Observation	Model
Coast	14	+0.04	+0.02
	44	+0.05	+0.02
	32	+0.04	+0.02
Valley	34	+0.04	+0.01
	27	+0.02	+0.00
	11	+0.00	-0.00
	17	+0.03	+0.01
	18	+0.01	-0.00
	52	+0.01	-0.00
Mountain	23	+0.03	+0.05
	47	+0.05	+0.00

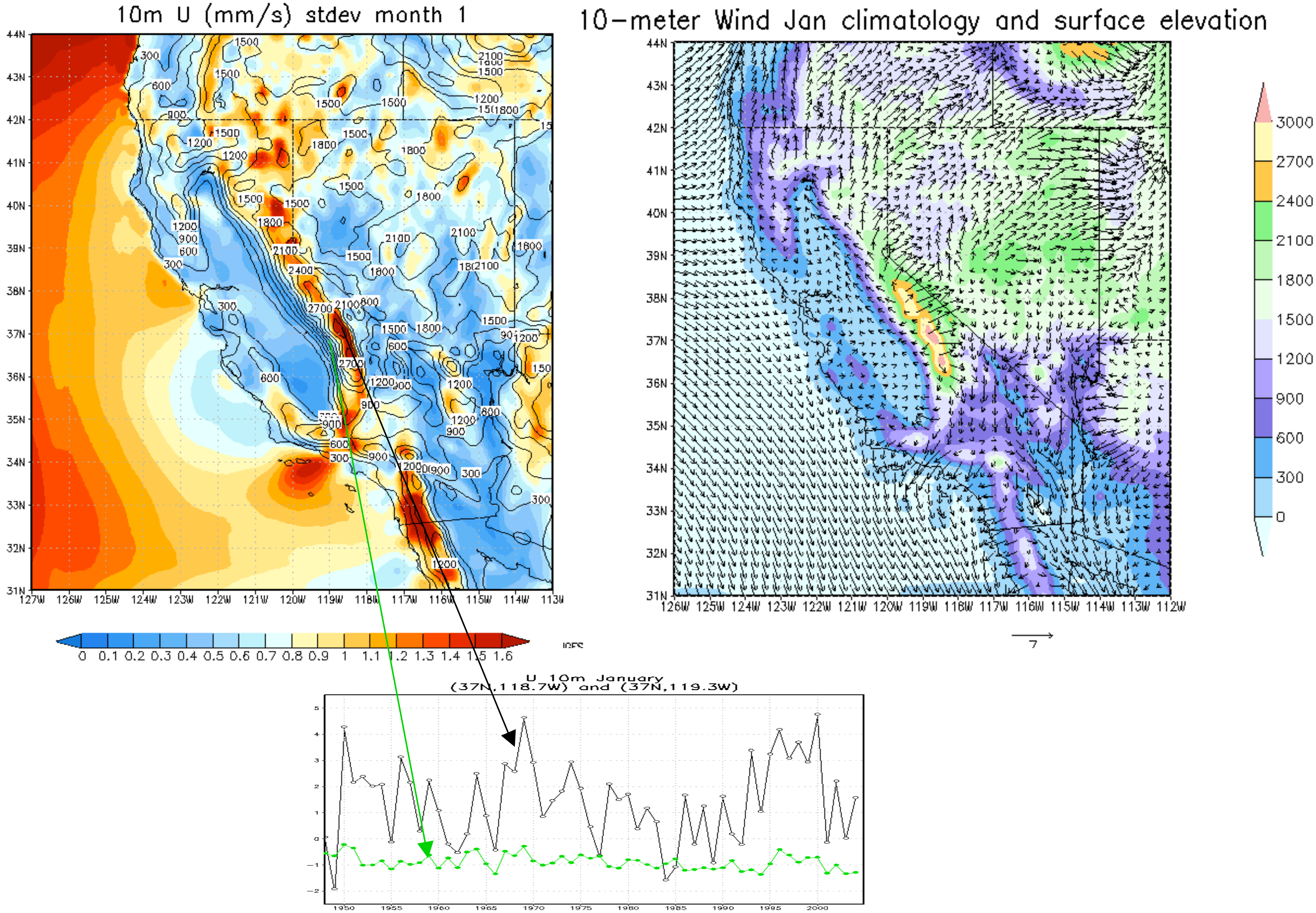
Long term trend



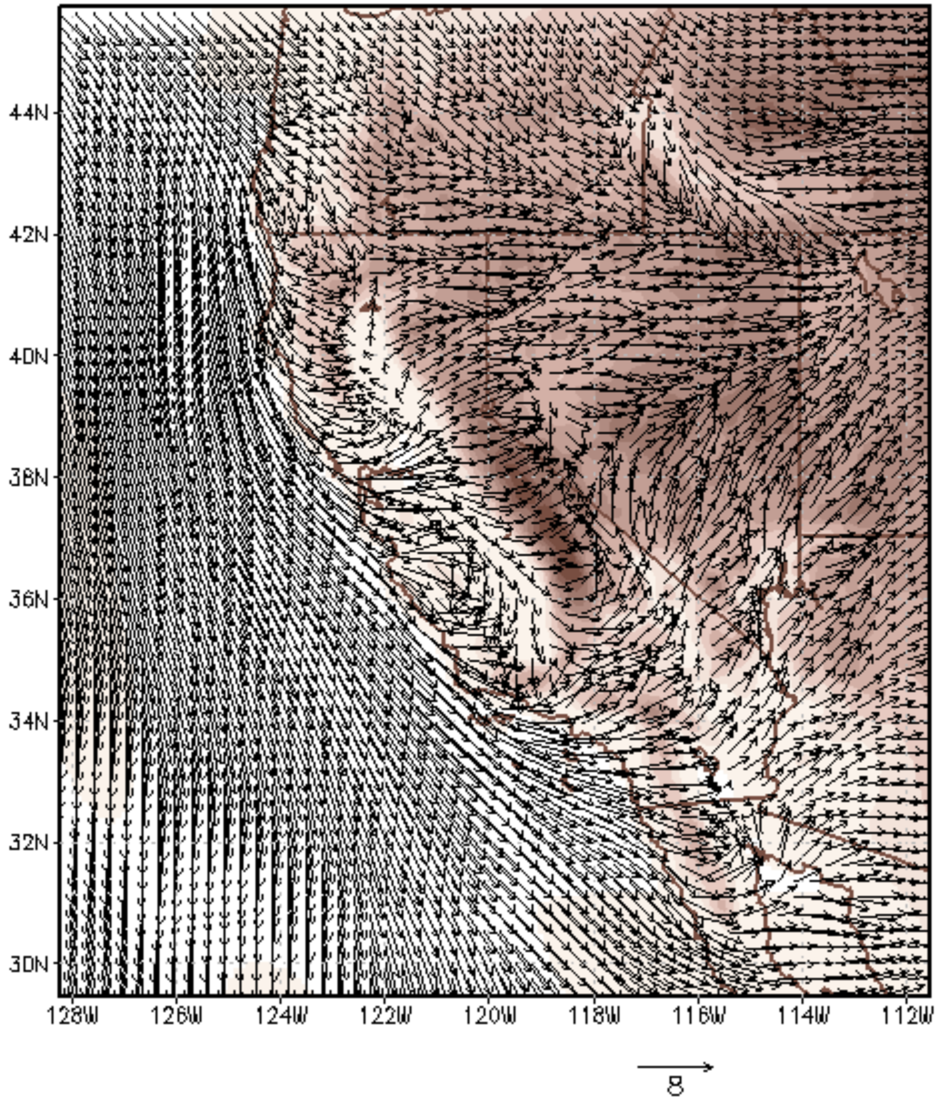

Jan Diurnal Variation Monthly Mean T2m
Western Slope South (36.5N, 119.0W)
283
282.5
282
281.5
281
280.5
280
279.5
279
278.5
278
277.5
00Z
1JAN
1948
03Z
06Z
09Z
12Z
15Z
18Z
21Z
GrADS: COLA/IGES
2005-08-30-11:49

Fact Finding Examples

Inter-annual variability of monthly means.



July 10-meter wind climatology at UTC=0



GrADS: COLA/IGES

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Standard pressure level fields

17 levels at:

1000, 925, 850, 700, 600, 500, 400, 300, 250, 200, 150 , 100, 70, 50, 30, 20, 10 hPa

1.	HGTprs	Geopotential height (gpm)
2.	UGRDprs	u wind (m/s)
3.	VGRDprs	v wind (m/s)
4.	TMPprs	Temperature (K)
5.	VVEL	Pressure vertical velocity (Pa/s)
6.	RHprs	Relative humidity (percent)
7.	SPFHprs	Specific humidity (kg/kg)
8.	ABSV	Absolute vorticity (/s)

2-dimensional fields

1. **PRESsfc** Sfc Pressure (Pa)
2. **PTEND** sfc Pressure tendency (Pa/s)
3. **PWAT** Precipitable water (kg/m**2)
4. **RHclm** column integrated relative humidity (percent)
5. **TMPtrp** Temperature (K) at tropopause
6. **PREStrp** Pressure (Pa) at tropopause
7. **UGRDtrp** u wind (m/s) at tropopause
8. **VGRDtrp** v wind (m/s) at tropopause
9. **VSSH** Vertical speed shear (1/s) at tropopause
10. **LFTX** Surface lifted index
11. **LFTXB** Best (4-layer) lifted index
12. **TMPmwl** Temperature (K) at max wind level
13. **PRESmwl** Pressure (Pa) at max wind level
14. **UGRDmwl** u wind (m/s) at max wind level
15. **VGRDmwl** v wind (m/s) at max wind level
16. **HGTsfc** Sfc Geopotential height (gpm)
17. **PRMSL** Pressure reduced to MSL (Pa)
18. **UFLX** Zonal component of momentum flux (N/m**2)
19. **VFLX** Meridional component of momentum flux (N/m**2)
20. **SHTFL** Sensible heat flux (W/m**2)
21. **LHTFL** Latent heat flux (W/m**2)
22. **TMPsfc** Sfc skin Temperature (K)
23. **SOILW1** Volumetric soil moisture content layer 1
24. **SOILW2** Volumetric soil moisture content layer 2
25. **TMPdlr1** Soil temperature layer1
26. **TMPdlr2** Soil temperature layer 2
27. **WEASD** Water equiv. of accum. snow depth (kg/m**2)
28. **DLWRF** Sfc Downward long wave radiation flux (W/m**2)
29. **ULWRFsfc** Sfc Upward long wave radiation flux (W/m**2)
30. **ULWRFtoa** Toa Upward long wave radiation flux (W/m**2)
31. **USWRFtoa** Toa Upward solar radiation flux (W/m**2)
32. **USWRFsfc** Sfc Upward solar radiation flux (W/m**2)
33. **DSWRFsfc** Sfc Downward solar radiation flux (W/m**2)
34. **TCDChcl** High cloud Total cloud cover (percent)
35. **PREShct** Pressure (Pa) high cloud top
36. **PREShcb** Pressure (Pa) high cloud bottom
37. **TMPhct** Temperature (K) high cloud top
38. **TCDCmcl** Mid-cloud Total cloud cover (percent)
39. **PRESmct** Pressure (Pa) mid-cloud top
40. **PRESmcb** Pressure (Pa) mid cloud bottom
41. **TMPmct** Temperature (K) mid-cloud top
42. **TCDClcl** Low cloud Total cloud cover (percent)
43. **PRESlct** Pressure (Pa) low cloud top
44. **PRESlcb** Pressure (Pa) low cloud bottom
45. **TMPlct** Temperature (K) low cloud top
46. **PRATE** Precipitation rate (kg/m**2/s)
47. **CPRAT** Convective precipitation rate (kg/m**2/s)
48. **GFLUX** Ground heat flux (W/m**2)
49. **LAND** Land-sea mask (1=land; 0=sea) (integer)
50. **ICEC** Ice concentration (ice=1; no ice=0) (1/0)
51. **UGRDhag** u wind (m/s) at 10m
52. **VGRDhag** v wind (m/s) at 10m
53. **TMPhag** Temperature (K) at 2m
54. **SPFHhag** Specific humidity (kg/kg) at 2m
55. **TMAX** Maximum temperature (K) at 2m
56. **TMIN** Minimum temperature (K) at tm
57. **RUNOF** Runoff (kg/m**2)
58. **PEVPR** Potential evaporation rate (w/m**2)
59. **UGWD** Zonal gravity wave stress (N/m**2)
60. **VGWD** Meridional gravity wave stress (N/m**2)
61. **HPBL** PBL height (m)
62. **SRWEQ** Snowfall rate water equivalent (kg/m**2/s)
63. **SNOEV** Snow sublimation heat fulx (W/m**2)
64. **SNOHF** Snow melt heat flux (W/m**2)
65. **QUFLX** Integrated moisture u-flux (m/s)
66. **QVFLX** Integrated moisture v-flux (m/s)
67. **CWAT** Plant canopy surface water (kg/m**2)
68. **DSWRFtoa** Toa Downward solar radiation flux (W/m**2)
69. **TCDCclm** Total cloud cover (percent)
70. **ALBDO** Albedo (percent)
71. **SFCR** Surface roughness (m)
72. **VGTYP** Vegetation type (nondim)
73. **VEG** Vegetation cover (percent)
74. **SLTY** Soil type (nondim)
75. **ALHTF** Alternate latent hflux (from prgtm) (nondim)
76. **ECPY** Canopy evaporation (w/m**2)
77. **BGRUN** Baseflow-groundwater runoff (kg/m**2)

Data volume

- 57-year hourly data : 5TB
- 1-year hourly data : 86 GB
- 57- year daily data : 250GB
- 57-year daily one variable : 1.3GB
- Monthly Averages : 8GB
- Monthly hourly averages : 220GB

Data Availability

- San Diego Super Computing Center is working on web access to full dataset.
- Data will also available by contacting kana@ucsd.edu or hkanamaru@ucsd.edu.
    - –Several compact datasets are available

End

Conclusions

1. California region downscaling is complete for 1948-present (Aug. 2005).
2. The quality of the downscaled analysis is very promising.
   - Excellent in winter
   - Reasonable in summer but not quite good for some variables over some regions.
3. The downscaled analysis is useful for global change research and applications.
4. Further validation of analysis is necessary.